
Carrier interface

Land-based carrier

The SL-1 RPE hardware interfaces with LD-1 carrier apparatus, which conforms to the T1 industry standard. Therefore, any carrier system conforming to T1 signaling standards should be able to interface with SL-1 RPE. Minor differences in carrier maintenance can generally be accommodated by option switches in the carrier interface card.

General engineering considerations

In addition to the T1 carrier rules, the following standards apply:

- The distance from local to remote equipment cannot exceed 112.7 km (70 mi).
- Line repeaters are powered from the office repeater bay (ORB), since no power is available from the SL-1 interface.
- The SL-1 interface with the LD-1 carrier line contains an M-type fault-location filter (3017 Hz) without level-of-polarity options. The FL filter is powered by the SL-1 RPE equipment. No other M-type filters can be used in the same span.

If an ORB is being used, the cable between the ORB and the cross connect (MDF) should have the following characteristics:

- The impedance presented to the SL-1 equipment should be 100 ohm at 722 kHz.
- The total distance between the SL-1 and the ORB or first line repeater should not exceed 228.6 m (750 ft).
- Cable should be designed for pulse code modulation (PCM) or digital signals, and should consist of individually shielded twisted pairs. Cable types NE-750A through NE-759A all meet these criteria.

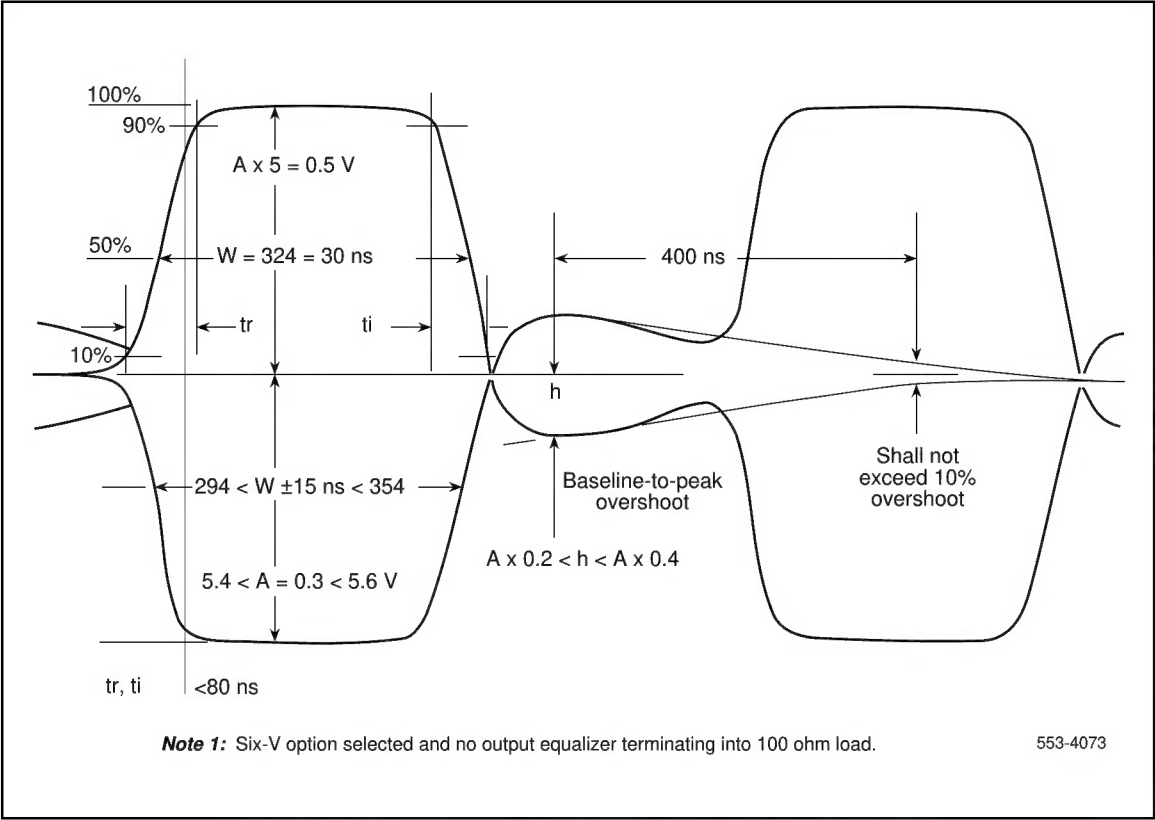
Carrier specifications

The SL-1 RPE is compatible with carrier facilities having the characteristics shown in [Table 2](#) and [Figure 12](#).

Table 2
Carrier characteristics

Line rate	1.544 Mb/s (± 200 b/s)
Signal	bipolar, 50% duty cycle
Output level	Option 1: If the equipment interfaces directly with the carrier line, or with an ORB that is less than 45.7 m (150 ft) away from the common equipment, the positive and negative output pulse heights are $3\text{ V} \pm 10\%$, and the imbalance between the positive and negative pulses is less than 5%. Option 2: When interfacing with an ORB that is between 45.7 m (150 ft) and 228.6 m (750 ft) away from the common equipment, the positive and negative output pulse heights are $6\text{ V} \pm 10\%$, and the imbalance between positive and negative pulses is less than 5%. With this configuration, one of two possible equalizers is inserted in the carrier line in order to make the total cable and equalizer loss about 6 dB. This will provide the required 3 V pulses at the ORB.
Output pulse width	The output pulse width at half pulse height is 324 ± 30 ns. Imbalance between positive and negative pulse width at half pulse height is less than ± 15 ns.
Output rise-and-fall time	The output rise-and-fall time is less than 90 ns.
Overshoot	The overshoot at the trailing edge of the output pulse is between 20% and 40% of pulse height, with decay to 10% or less of baseline-to-peak overshoot (within 400 ns).
Impedance	The nominal impedance at the line interface is 100 Ω .
Output jitter	The maximum jitter on the digital output signal can be 30 ns rms.
Input level	The positive and negative input pulse height will be in the range of 0.07 V to 3 V, with a possible imbalance between positive pulses of 5%.
Input jitter	The system can accommodate a low frequency input jitter of up to 20 ns rms. Jitter with frequencies above 2 kHz should not be more than ± 50 ns peak.
Interpulse time	The time between pulses in adjacent time slots will be 648 ns ± 20 ns.

Figure 12
Output pulse characteristics



In-house RPE

Since there is a carrier repeater located in the QPC99, it is not necessary to use ORBs and extra repeaters between the local and remote ends of the RPE if the distance between them is typically less than 762 m (2500 ft). In this case, the standard T1 procedures for cable installation should be followed. Other considerations are as follows:

- The impedance presented to the SL-1 system should be 100 ohm at 772 kHz.
- Unless the cable effectively separates transmit and receive pairs, separate cables for transmit and receive should be used to avoid crosstalk.
- Bridges, taps and loading coils, and building-out capacitors are to be avoided.
- Cable environment can affect transmission line capacitance and resistance, causing impedance mismatches and signal reflections. Cable should therefore be clean and dry.

Permissible in-house RPE operating distances depend on total losses and noise between the local and remote locations.

- If separate cables are used for transmit and receive directions, and if no noise or crosstalk from other pairs or external sources reaches the signal pairs, the maximum allowable loss at 772 kHz is 26 dB. In this case, the following approximate values apply:

Wire gauge (AWG)	Maximum cable length in meters (feet)
26	975 (3200)
24	1158 (3800)
22	1554 (5100)

- The following operating limits apply when several carrier systems are used without any additional equipment in the same group:

Wire gauge (AWG)	Maximum cable length in meters (feet)		
	4 RPE systems per group	8 RPE systems per group	12 RPE systems per group
26	762 (2500)	640 (2100)	579 (1900)
24	853 (2800)	732 (2400)	671 (2200)
22	1097 (3600)	914 (3000)	823 (2700)

- If only one twin carrier system and SL-1 equipment (such as SL-1 or 500-type telephones) are used in the same binder group, the following cable length limits apply:

Wire gauge (AWG)	Maximum cable length in meters (feet)
26	762 (2500)
24	853 (2800)
22	1079 (3600)

- If other high transient switching pairs are used in the same binder group, the maximum cable length is limited by LD-1 engineering rules for high noise environments and the following worst-case limits apply:

Wire gauge (AWG)	Maximum cable length in meters (feet)
26	579 (1900)
24	640 (2100)
22	732 (2400)

Microwave radio

Cabling between the SL-1 and the carrier facility should meet the criteria outlined for land-line carrier systems. In addition, the complete microwave system must also meet the overall limits for land-based carrier systems, and should conform to T1 interfacing specifications.

As in land-line carrier systems, the distance at which the SL-1 can operate is governed by a 1.5-ms timeout in the peripheral signaling card when interrogating the peripheral equipment. This 1.5-ms value is the maximum total round-trip time allowable, including propagation time and any delay introduced by signal processing at microwave stations. The maximum allowable distance (in miles) is given by:

$$M \times V - D$$

where

M = maximum allowable delay (ms)

V = propagation velocity (mi/ms)

D = any other processing delays (ms)

Example

In the case of a land-line system, assume that the maximum allowable delay (M) is 1.25 ms to give a safety margin of 0.25 ms. The propagation velocity (V) of signals through wire is 115 mi/ms. Assume that there are no delays (D) in the system. Thus the maximum allowable distance is 143.75 mi, as follows:

$$(1.25 \text{ ms} \times 115 \text{ mi/ms}) - 0 \text{ ms} = 143.75 \text{ mi}$$